

## MATERIALS PROCESSING

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### INCREASING THE EFFICIENCY OF MANUAL GRINDING OF TOP-QUALITY AND ART GLASS

A. V. Popov<sup>1</sup>

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The problem of increasing the efficiency of manual grinding of top-quality and art glass by increasing the durability of the binder and decreasing the relative diamond consumption is examined. It is established that in diamond wheels for grinding top-quality and art glass it is best to use binders with tungsten carbide powder and cobalt powder. Adding 10% tungsten carbide powder to the binder decreases the relative diamond consumption by 15–20%, and adding 10% cobalt powder to the binder decreases the relative diamond consumption by 45–50%. The roughness of the worked surface does not become worse in the process. The new wheels are successfully being used at 35 enterprises in the Czech Republic and Slovakia.

**Key words:** grinding, diamond wheel, graininess, top-quality and art glass, relative diamond consumption, cutting power.

At the present time 60–70% of articles made from top-quality and art glass are ground manually. It has been recommended that wheels with metal binders, HB75–85 hardness, and AS20 diamond powder be used for this technological operation [1, 2].

This article is devoted to further increasing the efficiency of manual grinding of top-quality and art glass by increasing the durability of the binder and decreasing the relative diamond consumption.

The investigations were performed by the procedure, regulated by GOST 30352–96, on a special facility based on a general-purpose grinder [3]. Constant clamping of the sample to the grinding wheel was done by a counter weight using blocks placed on the bed of the tool, and monitored by a dynamometer with scale division 1 N. The grinding depth was monitored with a height-and-depth gauge with scale division 0.1 mm. The grinding was performed using wheels with the shape 1E1 100 × 6 × 5 × 90 × 32. The velocity of the wheel was 26 m/sec, and the grinding depth was 3 mm. Glass bars (24 wt.% PbO) with dimensions 150 × 100 × 20 mm were ground using water as coolant.

The tests were performed for wheels with HB75–85 hardness and AS20 diamond powder with grain size

53/45 μm, which is usually used to work articles made of top-quality and art glass [4].

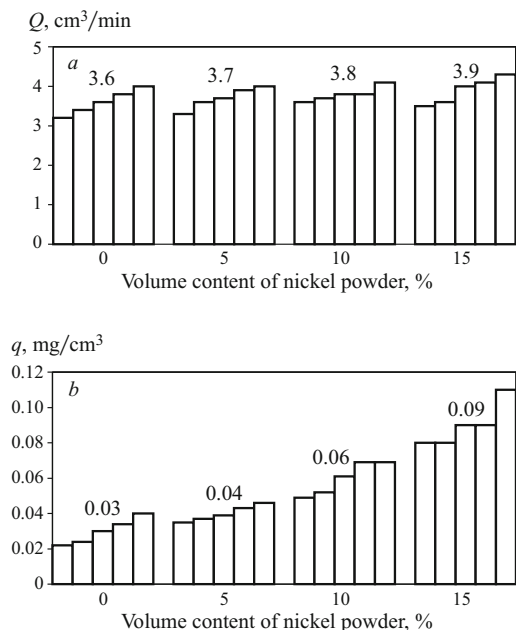
The relative diamond consumption was determined following GOST 16181–82 by weighing on VLT-1-1 balances. To determine the average value of the relative diamond consumption each experiment was performed five times.

The hardness of the diamond grains was monitored following GOST 9206–80 on the DA-2M apparatus, which was developed at the Institute of Superhard Materials of the Ukrainian Academy of Sciences [5]. For this, a diamond grain was placed between two parallel corundum plates and subjected to uniaxial compression with an evenly increasing load. The apparatus automatically recorded the force at which the grain fractured. To determine the average value 100 grains were crushed.

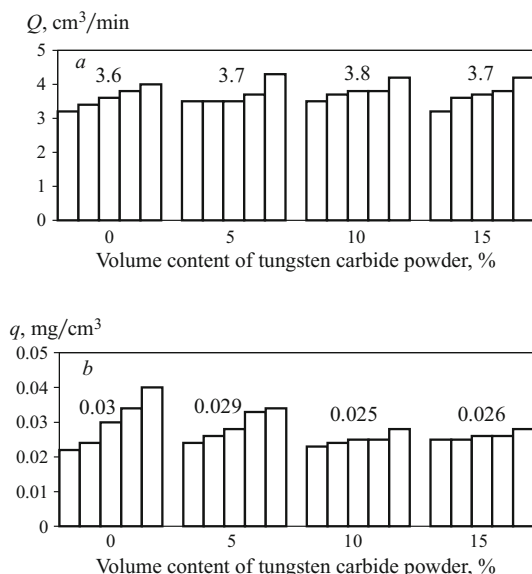
The quality of the worked surface was monitored with a model 201 profilograph-profilometer manufactured at the Kalibr plant. This was done so that a change of the composition of the binder would not increase the roughness of the worked surface.

To increase the durability of the binder and decrease the relative diamond consumption, 5–15% (here and below the calculation is done according to the volume of the binder) nickel, tungsten carbide, and cobalt powders were added separately into the binder of the diamond wheels [6]. The experimental results were used to construct the dependence of

<sup>1</sup> Technical University, Liberec, Czech Republic (e-mail: alespopov@yandex.ru).



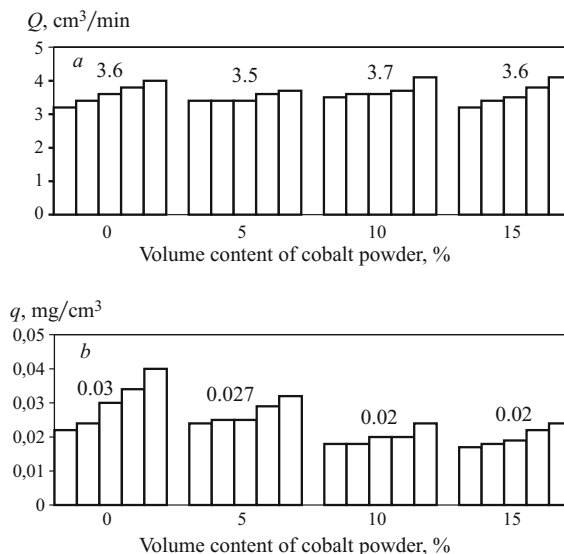
**Fig. 1.** Dependence of the cutting power  $Q$  (a) of a grinding wheel and the specific diamond consumption  $q$  (b) on the volume content of nickel powder in the binder of a grinding wheel.



**Fig. 2.** Cutting power  $Q$  (a) of a grinding wheel and specific diamond consumption  $q$  (b) versus the volume content of the tungsten carbide powder in the binder of the grinding wheel.

the cutting power and relative diamond consumption on the content of nickel powder (Fig. 1), tungsten carbide powder (Fig. 2), and cobalt powder (Fig. 3) in the binder of a grinding wheel.

It was determined that adding into the binder nickel powder to 15% increases the cutting power of the wheels by 10% (Fig. 1a) and the relative diamond consumption by a factor of 3 (Fig. 1b). Hence the introduction of nickel powder into



**Fig. 3.** Cutting power  $Q$  (a) of a grinding wheel and specific diamond consumption  $q$  (b) versus the volume content of the cobalt powder in the binder of the grinding wheel.

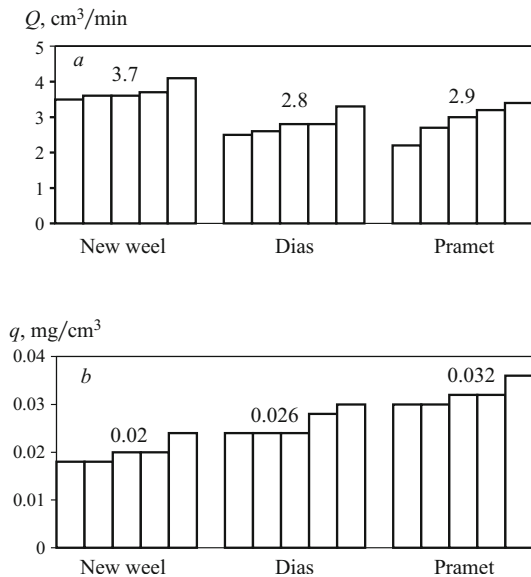
the binder does not increase the efficiency of manual grinding of top-quality and art glass.

Adding to the binder tungsten carbide powder in amounts up to 15% did not change the cutting power of the diamond wheels (Fig. 2a). A 10% content of tungsten carbide powder in the binder decreases the relative diamond consumption by 15–20% (Fig. 2b). A subsequent increase of the amount of tungsten carbide in the binder in amounts to 15% does not result in any further decrease of the relative diamond consumption. This means that the optimal addition of tungsten carbide powder to metal binder is 10%.

Adding to binder cobalt powder in amounts to 15% did not change the cutting power of diamond wheels (Fig. 3a). A content of cobalt powder in the binder of 5 and 10% decreased by 15–20 and 45–50% the relative diamond consumption, respectively (Fig. 3b). A subsequent increase of the amount of cobalt powder in the binder to 15% did not further decrease the relative diamond consumption. This means that the optimal addition of cobalt powder to the metal binder is 10%.

The roughness of the worked surface of the glass was measured by adding to the binder 5–15% tungsten carbide and cobalt powders. The results obtained showed that a change of the binder composition within the limits studied does not have a large effect on the roughness of the worked surface.

To compare the effectiveness of the new diamond wheels with addition of cobalt powder and diamond wheels from the leading manufacturer in the Czech Republic, dependences of the cutting power and relative diamond consumption were constructed (Fig. 4). It was found that the new diamond wheels with addition of cobalt powder make it possible to increase the cutting power by 30–35% and decrease by



**Fig. 4.** Cutting power  $Q$  (a) of a grinding wheel and specific diamond consumption  $q$  (b) for grinding wheels from the various manufacturer.

20 – 25% the relative diamond consumption as compared with the diamond wheels manufacture by the Dias Company. The new diamond wheels increase the cutting power by 25 – 30% and the relative diamond consumption by 35 – 40% as compared with the diamond wheels manufactured by the Pramet Company.

The results of the studies make it possible to recommend for commercial use the new wheels for manual grinding of top-quality and art glass with a binder to which 10% cobalt powder has been added. At the present time the new wheels are being successfully used at 35 enterprises in the Czech Republic and Slovakia.

It was found that a binder with tungsten carbide powder and cobalt powder is best for diamond grinding of top-quality

lity and art glass. Adding the optimal amount 10% tungsten carbide powder to the binder decreases the relative consumption of diamond by 15 – 20%, while adding to the binder the optimal amount 10% cobalt powder decreases the relative diamond consumption by 45 – 50%.

Adding tungsten carbide and cobalt to powders in amounts of 10% to the metal binder does not worsen the roughness of the worked surface.

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